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Space systems — Documents for space craft interface requirements for launch vehicle services

Systèmes spaciaux — Documents sur les exigences d'interchangeabilité des engins spaciaux pour les services de lancements spaciaux

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

ISO 17401 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

Introduction

This International standard gives guidelines for writing an Interface Requirements Document (IRD) for Launch Vehicle (LV) services. The application of this Standard is intended to facilitate the technical exchanges between Spacecraft (SC) and Launch Vehicle Agencies. By reducing the amount of work necessary for requesting launch services, this Standard will minimize Spacecraft contractors and Spacecraft manufacturer's costs.

The standard is presented in the form of a questionnaire. In some cases drawings are explicitly requested in order to provide comprehensive information. Explicit International System units are specified for all items. The corresponding scale may be adjusted if not appropriate.

SC organizations may include additional topics if required. Some sections of this document may refer to specificity's that are not applicable to the Launch Services of interest, in which case they should be ignored.

Space systems — Spacecraft interface requirements document for launch vehicle services

1 Scope

This International Standard provides Spacecraft organizations with the general format for presenting the Interface Requirement Document for Launch Vehicle Services. This document provides a list of the major technical requirements Spacecraft Agencies shall provide to Launch Vehicle Agencies when submitting an application for launch services.

This document addresses the definition of the SC mission, the mechanical and electrical interfaces, the overall environment requirements (mechanical, thermal, cleanliness, Radio–Electrical), the SC development and test program and, finally, launch range facilities and support requirements.

This International Standard is applicable to all existing commercial launch vehicles and related launch facilities so as to permit Spacecraft Contractors to prepare a single Interface Requirement Document for a given Spacecraft mission, independently of the Launch Vehicle Contractor to be selected.

The IRD as defined in the present Standard includes the basic Spacecraft input data needed by Launch Vehicle Agencies to prepare the Interface Control Document defined in the ISO Standard 15863.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 14303, *Spacecraft to Launch Vehicle Interfaces.*

ISO 15863, *Spacecraft to Launch Vehicle Interface Control Document*

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

3.1
usable volume
the volume available to the payload within the LV fairing or carrying structure that the static envelope of the SC may not exceed in order to ensure that there is no physical contact between the SC and the LV in a dynamic environment

3.2
payload adapter
the structure that mates the SC to the LV and includes the separation system for SC/LV separation

NOTE The payload adapter is a part of the LV and does not separate with the SC

4 Spacecraft mission description

4.1 Mission description

— Purpose

— Orbital characteristics

— In orbit view of SC drawing

4.2 SC description

— SC platform

— SC payload

NOTE This Chapter is optional

5 Mechanical interfaces

5.1 Mechanical configuration

— SC mechanical drawing (launch configuration) drawing

— SC coordinate system drawing

— Maximum height above interface plane _____ m

— SC maximum diameter _____ m

— SC / LV interface diameter _____ m

5.2 SC fundamental frequencies

Fundamental natural frequencies (specify boundary conditions):

— Axial _____ Hz

— Lateral _____ Hz

5.3 Usable volume

— Static envelope drawing

— SC protrusions below I/F plane (dimensioned drawings) drawing

— SC volumetric displacement _____ m^3

— SC free air volume _____ m^3

— Special clearance requirements

5.4 Spacecraft (or SC adapter) mechanical interface

- Mechanical interface — drawing
- Diameter — _____ m
- Attachments at SC interface
- Material
- Young's modulus — _____ N/m2
- Coating:
  - Surfaces in contact
  - Other surfaces
- Roughness — _____ m
- Flatness / Perpendicularity
- Stiffness (for clampband mating system):
  - Applicable length (height) — _____ m
  - Section area — _____ m^2
  - Inertia (with respect to center of gravity of section) — _____ m^4
- Stiffness (except for clampband mating systems)
  - Radial direction — _____ N/m
  - Tangent direction — _____ N/m

NOTE This Section applies to the lower adapter interface ring for a SC provided adapter

5.5 5.5 Connectors and microswitches (SC side of the interface)

- Manufacturer and part number
- Quantity — _____
- Location and mechanical I/F (with drawing) : — drawing
  - Angular position — _____ deg
  - Radial position — _____ m
  - Height from separation plane — _____ m
- Push-on and push-off loads — _____ N
- Energy released — _____ J
- Keying index

5.6 Purges and fluid connection interface

— Definition

— Location and mechanical I/F: drawing

  — Angular position _____ deg

  — Radial position _____ m

  — Height from separation plane _____ m

5.7 Encapsulated spacecraft access

Access doors in payload compartment:

— Number _____

— Minimum size _____ m x m

— Location drawing

— Purpose

6 Electrical interface

6.1 Umbilical wiring diagram

SC to LV and SC to ground facilities wiring drawing

6.2 Umbilical connectors

— Number of connectors required _____

— LV supplied Y/N

— Manufacturer

— Part number _____

— Number of pins needed for user _____

— Polarizing key orientation

— Insert key location drawing

— Location drawing

— Backshell shielding requirement

— Harness shielding requirement

6.3 Umbilical wiring links (for each connector pin)

— Pin number _____

— Function(s)

— Wire type

— Twisting and shielding characteristics

— Maximum voltage _____ V

— Maximum current _____ A

— Maximum one way resistance _____ Ω

— Maximum voltage drop _____ V

— Line start point

— Line end point

— Maximum voltage at separation (if applicable) _____ V

— Maximum current at separation (if applicable) _____ A

— Signal type

— Signal frequency _____ Hz

6.4 Electrical commands dedicated to spacecraft

6.4.1 Pyrotechnic commands

— Number of commands required _____

— Electrical circuit drawing drawing

— Command identification

— Number of initiators per command _____

— Time of command initiation

— Minimum time interval between commands _____ s

— Pulse width _____ s

— Voltage _____ V

— Minimum all fire current _____ A

— Maximum no fire current _____ A

— Output isolation _____ Ω

— Wire gage

— Wire type

— Wire length from LV-SC interface _____ m

— Circuit connectors to pyro devices

— Initiator characteristics

6.4.2 Dry loop commands

— Number of commands required _____

— Command identification

— Number of redundant commands _____

— Time of command initiation (on ground or in flight)

— Resistance (ON/OFF configurations) _____ Ω

— Maximum, minimum & nominal output voltage _____ V

— Maximum current _____ A

— On board circuit isolation _____ Ω

— Grounding requirements

— SC circuit configuration drawing

6.4.3 Electrical commands

— Number of commands required _____

— Command identification

— Number of redundant commands _____

— Time of command initiation (on ground or in flight)

— Minimum time interval between commands _____ s

— Maximum, minimum & nominal output voltage _____ V

— Maximum current _____ A

— Current profile characteristics

— Command duration _____ s

— Grounding requirements

6.5 Separation status transmission

Measurement used to confirm SC separation.

6.6 SC in-flight telemetry

— Number of channels _____

— Type of measurements

— Transducer range

— Signal voltage _____ V

— Sample rate _____

— Encoding format

— Source impedance _____ Ω

6.7 Power supply required from LV

— Ground phase Y/N

— Flight phase Y/N

— Voltage & stability _____ V±ΔV

— Current required _____ A

— Frequency _____ Hz

— Ripple noise < ___ %

6.8 Earth potential continuity

— Location of reference point on SC

— Max. resistance between SC metallic elements and reference point _____ Ω

— Max. resistance for SC interface plane _____ Ω

7 Radio-frequency and electromagnetic interface

7.1 Characteristics of radio-electrical systems

— Number of units _____

— Type of units

— Unit designation

— Function of unit

— Frequency band (S,L,C,Ka,Ku) _____

— Carrier frequency _____ Hz

— Bandwidth corresponding to

  — 3 dB attenuation _____ Hz

  — 60 dB attenuation _____ Hz

- — or, 99% bandwidth (polar polarization) _____ Hz
- — Carrier modulation :
  - — Type
  - — Index
  - — Bit rate _____ bps
  - — Sub carrier frequency _____ Hz
- — Carrier polarization
- — Receiver frequencies (if required by LV contractor):
  - — Local oscillator _____ Hz
  - — First intermediate _____ Hz
  - — Second intermediate (if applicable) _____ Hz
- — Transmitter power (EIRP): nominal and maximum value _____ W
  - — Field strength of receiver antenna:
  - — Minimum, nominal and maximum values _____ W/m2
- — Antenna description:
  - — Location drawing
  - — Pattern & gain
- — SC transmission plan

7.2 RF telemetry and command link

7.2.1 SC RF link definition for ground operations

- — Number of sources and corresponding frequency bands
- — Type of link requested (if several options are available)
- — Purpose of link
- — Link destinations
- — Events corresponding to link activation and time-table

7.2.2 SC antenna coordinates

- — Identification
- — Coordinate measures in the SC reference frame _____ m

— Field of view drawing

7.2.3 RF link implementation

— RF source

— SC location

— Purpose

— RF receive location

7.2.4 RF link budget

— SC Telecommand

  — At SC test equipment output :

    — Frequency of signal _____ Hz

    — Bandwidth _____ Hz

    — Output power (max, nominal, min) _____ W

    — Modulation

  — At SC omni antenna :

    — Frequency of signal _____ Hz

    — Power density (max, nominal, min) _____ W/m2

— SC telemetry

  — At SC omni antenna :

    — Frequency of signal _____ Hz

    — Bandwidth _____ Hz

    — Output power : EIRP (max, nominal, min) _____ W

  — At SC test equipment input:

    — Frequency of signal _____ Hz

    — Power density (max, nominal, min) _____ W/m^2

7.2.5 Base band signal characteristics

— Telemetry

  — Number of channels _____

  — Digital:

- Encoding
- Bit rate _____ bps

- Analog:
  - Modulation type & index
  - Frequency _____ Hz

- Acceptable input from SC:
  - Level __±__ V
  - Offset _____ V

- Adjustable output to electrical support equipment:
  - Level __±__ V
  - Offset _____ V

- Telecommand:
  - Number of channels _____

- Digital:
  - Encoding
  - Bit rate _____ bps

- Analog:
  - Modulation
  - Frequency _____ Hz

- Acceptable input from electrical support equipment:
  - Level __±__ V
  - Offset _____ V

- Adjustable output to SC:
  - Level __±__ V
  - Offset _____ V

8 Spacecraft mission characteristics

8.1 SC input data for mission analyses

8.1.1 Mass and inertia characteristics

— Mass ___± ___ kg

— Center of gravity (origin on centerline, at I/F plane)

  — X_S ___±___ m

  — Y_S ___±___ m

  — Z_S ___±___ m

— Static unbalance ___±___ m

— Moments of inertia (with respect to SC center of gravity)

  — I_{xx} ___±___ m^2 x kg

  — I_{yy} ___±___ m^2 x kg

  — I_{zz} ___±___ m^2 x kg

  — I_{xy} ___±___ m^2 x kg

  — I_{xz} ___±___ m^2 x kg

  — I_{yz} ___±___ m^2 x kg

— Dynamic unbalance (for spinning SC) ___±___ deg

NOTE Launch configuration and separation configuration if different

8.1.2 Sloshing masses (pendulum-type)

— Type of tank (bladder, material, etc.)

— Type of propellant

— Maximum volume of tank _____

— Filled volume _____ m^3

— Fluid fill factor _____ %

— Mass of liquid _____ kg

— Center of gravity of wet tank in SC reference frame:

  — X_S _____ m

  — Y_S _____ m

- Z_S _____ m

— Slosh model :

- Mass (corresponding to sloshing fraction) _____ kg
- Length _____ m
- Location of attachment point with respect to the tank:
  - X_S _____ m
  - Y_S _____ m
  - Z_S _____ m
- First sloshing frequency (one-g model) _____ Hz

NOTE s = SC

8.1.3 SC mission constraints (when applicable)

— Aerothermal flux

— Solar aspect angle

— Telemetry data acquisition

— Angular accelerations / velocities

— Deployment of appendages

— Use of inertial units

— Others

8.2 SC orbit parameters (with tolerances)

— Inclination __±__ deg

— Altitude of perigee __±__ m

— Altitude of apogee __±__ m

— Argument of perigee __±__ deg

— Longitude of descending node with respect to the Greenwich meridian __±__ deg

8.3 Launch window

8.3.1 Launch window constraints (when applicable)

— Solar aspect angle

— Sun eclipse

— Moon eclipse

— Ground station view angle

8.3.2 Preferred window

— Launch period and launch window

NOTE For dual or multiple launches, refer to LV User's Guide.

8.4 SC pointing and separation

— Allowable angular rate :

  — Spin __±__ rpm

  — Roll, pitch & yaw (3-axis stabilized SC) __±__ deg/s

— Separation attitude

  — Separation velocity __±__ m/s

  — Maximum allowable pointing error (cone angle) _____ deg

  — Maximum allowable tip-off rate _____ deg/s

  — Maximum allowable angular acceleration _____ deg/s2

NOTE Refer to LV User's Guide for reference frame definition

9 Environment requirements

Requirements below apply to both flight and ground processing operations (as applicable)

9.1 Mechanical environment

— Maximum allowable acceleration (static + dynamic) longitudinal _____ g

— Maximum allowable acceleration (static + dynamic) lateral _____ g

— Allowable longitudinal sine vibration curve drawing

— Allowable lateral sine vibration curve drawing

— Allowable longitudinal random vibration curve drawing

— Allowable lateral random vibration curve drawing

— Allowable acoustic curve drawing

— Allowable shock curve drawing

9.2 Thermal environment

— Allowable air temperature range:

- Ground processing with SC 'on' _____ to _____ °C
- Ground processing with SC 'off' _____ to _____ °C
- After encapsulation _____ to _____ °C
- Pre-launch phase _____ to _____ °C

— Allowable humidity range :

- SC processing _____ to _____ %
- After encapsulation _____ to _____ %
- Pre-launch phase _____ to _____ %

— Maximum pre-launch air impingement velocity _____ m/s

— Maximum ascent heat flux:

- Pre-fairing jettison _____ W/m^2
- Post fairing jettison _____ W/m^2

— Maximum free-molecular heat flux:

- At fairing jettison _____ W/m^2
- Following fairing jettison _____ W/m^2

— Heat dissipation:

- SC processing _____ W
- After encapsulation _____ W
- Pre-launch phase _____ W

— Thermal analysis required from LV contractor drawing

9.3 Static pressure

— Maximum allowable ascent depressurization rate _____ Pa/s

— Maximum allowable ascent differential pressure _____ Pa/s

9.4 Contamination and cleanliness control

— Fairing air cleanliness _____ Class

— Maximum deposit on SC surfaces _____ kg/m2

— Outgassing - Total mass loss _____ %

— Outgassing - Volatile condensable material weight loss _____ %

9.5 Radio frequency and electromagnetic environment

— SC Radiation spectrum diagram — drawing

— SC Radiated susceptibility — drawing

9.6 Environment monitoring

— In-flight environment data acquisition:

  — Temperature — Y/N

  — Pressure — Y/N

  — Accelerations (low frequency vibrations) — Y/N

  — Shocks — Y/N

— Launch range operations & transport data acquisition:

  — Temperature — Y/N

  — Humidity — Y/N

  — Cleanliness — Y/N

  — Accelerations (low frequency vibrations) — Y/N

  — Shocks — Y/N

10 SC Development and test program

10.1 Mechanical environment qualification tests

— List of applicable tests:

  — Static load — Y/N

  — Modal survey — Y/N

  — Sinusoidal vibration — Y/N

  — Acoustic noise — Y/N

  — Random vibration — Y/N

  — Separation shock — Y/N

— Flowchart and test schedules — drawing

10.2 LV / SC compatibility tests

— List of applicable tests:

  — Match-mate — Y/N

- — Separation Y/N
- — Umbilical connector pull-out Y/N
- — Clearance measurement Y/N
- — EMC Y/N
- — End to end electrical Y/N
- — RF link Y/N
- — Other Y/N

— Operations flowchart and test schedules drawing

11 Launch range operations: facilities and support requirements

11.1 General logistics requirements

11.1.1 General

The requirements listed below shall be defined for each relevant facility and each item.

11.1.2 SC container & ground support equipment physical envelopes

— Height _____ m

— Width _____ m

— Length _____ m

— Weight _____ kg

11.1.3 Material handling equipment

11.1.4 Electrical power for SC and ground station:

— Voltage _____ V

— Frequency _____ Hz

— Power _____ W

— Special requirements Y/N

- — Stability of power _____ %
- — Other

— Back-up power

- — Continuous Y/N
- — During specific periods (explain) Y/N

11.1.5 Umbilical lines & ground lines:

— Number of lines _____

— Purpose

— Type of lines (electrical characteristics)

— Connectors provided by SC Y/N

— Umbilical shielding

— Ground reference

11.1.6 Gas and fluid lines

— Number of lines

— Purpose

— Type of lines

— Type of fluid or gas

— Operating pressure __±__ Pa

— Connectors provided by SC Y/N

11.1.7 Clean room **Y/N**

— Working dimensions

  — Area m^2

  — Height m

— Cleanliness class _____

— Special sampling technique

11.1.8 Environmental controls for SC and ground station

— Temperature + tolerances __±__ °C

— Humidity + tolerances __±__ %

— Checking frequency Times / day

— Downtime allowable in case of failure ____ s

— Back-up air-conditioning system required Y/N

— Back-up power

  — Continuous Y/N

— During specific periods (explain) Y/N

11.1.9 Clothing (safety and cleanroom)

— Location for use

— Type of hazardous operations

— Type of garment

— Type of protection

— Availability

11.1.10 Area

— For SC _____ m^2

— For ground station _____ m^2

— For office space _____ m^2

— For other ground support equipment _____ m^2

— For storage _____ m^2

11.1.11 Storage (non hazardous items)

— List of items to store

— Environment

— Temperature _____ °C

— Humidity _____ %

— Other

11.1.12 SC pre-launch activities calendar:

— Assembly and testing timeline

— Hazardous operations timeline

— Turn-on of high power Radio Frequency system

— Initial pressurization

— Hazardous ordnance installation

— Fuel loading

— Mating operations

11.1.13 Special technical support equipment

— Weighing device

  — Scale __±__ kg

  — Load cells available Y/N

— Dynamic balance machine

  — Capacity _____ kg

  — Spin rate __±__ rpm

  — Type of interface

11.1.14 Other

11.2 Specific requirements for solid propellant motor facilities

11.2.1 Solid propellant motor storage	**Y/N**
— Size area	_____ m^2
— Environment	
— Temperature	_____ °C
— Humidity	_____ %
— Other	
— Electrostatic discharge protection	Y/N

11.2.2 Pyrotechnics storage	**Y/N**
— Size area	_____ m^2
— Environment	
— Temperature	_____ °C
— Humidity	_____ %
— Other	
— Electrostatic discharge protection	Y/N

11.3 Specific requirements for X-ray facilities

— X-ray equipment (explain) Y/N

— Turntable Y/N

— Film processing Y/N

— Cold soak Y/N

11.4 Specific requirements for hazardous operations facilities

11.4.1 Gases :

— Specification

— Procured by user Y/N

— Quantity _____ m^3

— Supply pressure __±__ Pa

— Sampling Y/N

11.4.2 Liquid propellant:

— Specification

— Procured by user Y/N

— Quantity _____ m^3

— Supply pressure __±__ Pa

— Sampling Y/N

— Storage

  — Period and duration _____ days

  — Size area _____ m^2

  — Environment

    — Temperature _____ °C

    — Humidity _____ %

    — Other

— Transfer conditions

11.4.3 SC purge requirement

11.4.4 SC fluid requirements

11.5 Payload handling and transport requirements

— Payload to transport (SC, composite or other)

— Itinerary and timelines (optional) drawing

— Type of transport & handling operations

— Transport & handling equipment

— Container for transportation supplied by SC agency Y/N

— Environmental conditions

— SC purge Y/N

— SC fluids Y/N

— General :

  — Weather forecast Y/N

  — Security Y/N

11.6 Communication requirements

— External lines (telephone)

— Range telephone network

— Operational intercom system

— Closed circuit television

— Countdown clocks

— Timing

11.7 General range services

— Chemical analysis laboratory (specify analysis type)

— Mechanical and electrical workshop Y/N

— Optical and photographic workshop Y/N

— Measuring instruments laboratory Y/N

— Security service Y/N

— Industrial waste disposal (specify type)

— Weather forecast (including time range) Y/N

12 Other requirements

Any other requirement that the SC contractor wishes to add to the above standard list.